RELATIONSHIP BETWEEN INTRAMUSCULAR FAT, PROTEIN AND CONNECTIVE TISSUE CONTENT IN LONGISSIMUS MUSCLE FROM HUNGARIAN SIMMENTAL BULLS

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Abstract – The aim of this study was to analyze the association between intramuscular fat level and protein content as well as hydroxyproline/collagen in longissimus muscle of Hungarian Simmental bulls. For the determination of the intramuscular fat level two methods was used. Altogether 39 longissimus muscle samples were taken from the right half carcasses at 12. ribs after 24hrs chilling. The X-ray computed tomography examination of rib cuts was performed by using a 16-slice CT system (Siemens Somatom Sensation Cardiac). After CT, Weendei analysis was performed. Hydroxyproline content was used to determine collagen content in meat. Close correlation was detected between CT measured fat content and laboratory fat (r=0.93). The fat percentage showed moderate negative relationship with collagen, and the protein content correlated negatively with fat content and with collagen.

Key Words – beef quality, marbling, non-invasive measurement

I.   INTRODUCTION

The three major muscle constituents (protein, fat, connective tissue) influence both nutritional and sensorial meat quality components. Among these traits intramuscular fat level (marbling) is one of the most important quality characteristics of meat demanded by consumers [4]. The intramuscular fat simply quantifies the amount (percent) of fat within the muscle, but marbling considers amount, distribution, and texture of fat, too. Nowadays several innovative instrumental methods are being applied in meat industry in order to realize the rapid and on-line evaluation of marbling degree. One of them is the X-ray computed tomography (CT) method. Previously, Andersson *et al.* [1] found that the ability of CT to predict IMF% was greatest in case of the longissimus muscle from the 5 examined muscles in lamb carcasses. On the other hand, Moon [3] stated that longissimus muscle could be used to predict tenderness of other major muscles in Hanwoo beef. Moreover, a higher marbling score and a better texture score tended to have a lower total collagen content, and Warner-Bratzler shear force. Guzek *et al.* [2] analyzed the correlation between basic muscle composition and sarcomere length in beef from Limousine bulls. The sarcomere length may partly explain differences in protein content of muscle. It was shown that sarcomere length positively correlated with marbling level and negatively correlated with protein content.

The aim of this study was to analyze the association between intramuscular fat level and protein content as well as hydroxyproline/connective tissue proportion in longissimus muscle of Hungarian Simmental bulls. The tissue composition was analysed with the usage of X-ray computed tomography method and laboratory examination, too.

II.   MATERIALS AND METHODS

We collected randomly, altogether 39 muscle samples from Hungarian Simmental bulls in a commercial Hungarian abattoir. The animals were slaughtered at average 492 ± 228 days of age and 504.6 ± 117.1 kg of weight. The samples were taken from the right half carcasses at 12. ribs after 24hrs chilling. The CT-examination of rib cuts was performed by using a 16-slice CT system (Siemens Somatom Sensation Cardiac, slice thickness: 5mm). On each scan the longissimus muscle area as ROI (region of interest) was selected by manual method. Volumetric intramuscular fat (-200 - 19 CT value) and muscle (20-150 CT value) percentage was determined and with the usage of MANGO (3.8, 2016) software. After CT examination, a chemical analysis was performed (Weendei analysis). Hydroxyproline measurement was used to determine connective tissue (collagen) content in meat. Total collagen was calculated as hydroxyproline $\times$ 7.25 and expressed as g of collagen per 100 g of muscle. For statistical analysis SPSS 20.0 program package was used.

III.   RESULTS AND DISCUSSION

The nutritional value of macronutrients such as protein, fat, and minerals and its role to integrate as a part of a healthy diet depends on several factors including, the level, composition and their bioavailability [5]. In our study similarly to previous data; the average moisture, protein, lipid, and ash content as well as collagen of longissimus muscle cuts of beef were 74.53%, 21.59%, 2.48%, 1.09%, and 0.54% respectively. Marbling of

muscles has a role in eating quality of beef in terms of tenderness and juiciness. We analysed two components on CT scans within the area of longissimus muscle; the percentage of muscle tissue and fat tissue also were determined. The mean percentage of muscle and fat tissue were 94.79% and 1.62% respectively.

Results of correlation summarised in Table 1 indicated that strong negative correlation was between fat and water content of muscle samples. Moreover - as expected - the chemical fat and CT muscle content controversially changed. Opposite relationship was investigated between CT fat and chemical fat content of muscle. Intramuscular connective tissue plays a significant role in determining meat tenderness. The main component of is intramuscular connective tissue collagen and generally it has been called "background" toughness of meat. The collagen and ash content of muscle correlated to protein content. Furthermore, a positive relationship was detected between collagen and water content and CT muscle content as well as ash percentage of muscle.

Table 1. Correlation coefficients (r) of muscle components

Variable, %	Water	Protein	Fat	Ash	CT fat	CT muscle	Collagen
Water	-						
Protein	x	-					
Fat	-0.87	-0.55	-				
Ash	0.45	0.54	-0.72	-			
CT fat, %	-0.83	-0.46	0.92	-0.73	-		
CT muscle	0.73	0.45	-0.91	0.63	-0.96	-	
Collagen	0.51	-0.27	-0.20	0.17	-0.38	0.27	-

$P<0.001$ $r<0.5$; $P<0.01$ $r<0.3$; $P<0.05$ $r<0.2$

IV. CONCLUSION

Further research should investigate on the modulation of these muscle properties that determine the major components of meat quality in cattle. The CT scans of longissimus muscle can be used for the evaluation of some tissue components especially intramuscular fat content in Hungarian Simmental cattle.

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